Population survey and trend assessment for *Eucephalus vialis* at Beatty Creek ACEC

Final Report
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PREFACE

This report is the result of a cooperative Challenge Cost Share project between the Institute for Applied Ecology (IAE) and the USDI Bureau of Land Management. IAE is a non-profit organization dedicated to natural resource conservation, research, and education. Our aim is to provide a service to public and private agencies and individuals by developing and communicating information on ecosystems, species, and effective management strategies and by conducting research, monitoring, and experiments. IAE offers educational opportunities through internships. Our current activities are concentrated on rare and endangered plants and invasive species.

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INTRODUCTION

Background

Eucephalus vialis (*Aster vialis* synonym; Figure 1) is a BLM Survey and Manage Species. It is also listed as threatened by the state of Oregon and as a Species of Concern with the U.S. Fish and Wildlife Service (ORNHIC 2007). The population of *E. vialis* at Beatty Creek Area of Critical Environmental Concern (ACEC) most likely represents the northern-most population of this species on serpentine-derived soil.

Figure 1. *Eucephalus vialis* inflorescence. Photo by T.N. Kaye.

Study Area

Beatty Creek ACEC encompasses 850 acres around the lower portion of the Beatty Creek watershed, a small perennial stream that drains into Cow Creek, a tributary of the South Umpqua River (Carter 2004). Situated in the northern portion of the Klamath Mountains Ecoregion, a significant extent of the Beatty Creek ACEC is underlain by serpentine bedrock. Distinctive edaphic characteristics of the serpentine-derived soils promote a unique *Pinus jeffreyi* savanna community that occupies much of the drier habitat in the Beatty Creek drainage. Taxa associated with this savanna include *Ceanothus cuneatus, Holodiscus discolor,* and *Toxicodendron diversilobum. Arbutus menziesii* and *Pseudotsuga menziesii* are present in ephemeral drainages, while the Beatty Creek drainage itself harbors *Cupressus lawsoniana, Umbellularia californica, Fraxinus latifolia, Acer macrophyllum, Taxus brevifolia, Alnus rubra,* and *Rhododendron occidentale*. Exotic species contribute little to overall plant cover and richness, and include *Hypericum perforatum, Cynosurus echinatus*, and annual members of *Bromus*, among others.

Natural history of Eucephalus vialis

Eucephalus vialis reproduces sexually by seed and vegetatively over short distances (<20 cm) with rhizomes. Flowering usually occurs from mid-July to September. Although seed production is evident, seeds are often nonviable. In one study, seed set was only 0.1% to 4.3% depending on the site, and all plants formed less than one seed per flower head on average (Kaye 2001). Seedling recruitment appears to be limited or nonexistent within certain populations (BLM files, Thorpe *et al.* 2010). Seeds are primarily wind dispersed, but many remain near the parent plant (Gammon 1986). Vegetative reproduction is common within populations, making it difficult to differentiate individuals in some cases. In 1990, a study of *E. vialis*' breeding system found that the species is sexually self-incompatible; meaning insect transport of pollen between separate individuals is required for seed production (Kaye et al. 1991). In addition, seed set is significantly higher in experimental pollination crosses between plants from different populations than between plants from the same population, suggesting that habitat fragmentation

may isolate plants and cause inbreeding depression due to reduced long distance pollination. Because inbreeding depression can occur when pollen flow is restricted to a single site, maintaining as many of the known sites as possible in a reproductive state, large population sizes, and connectivity between populations is important to the long term viability o f *E. vialis* (Kuykendall 1991).

Project objectives

The primary objective of this study is to determine long-term population trends of *E. vialis* at Beatty Creek. In 2009, IAE surveyed Beatty Creek ACEC to determine the size of the *E. vialis* population. We used this information to design a long-term monitoring protocol and conduct population monitoring. This protocol was used to survey the population again in 2010. IAE has conducted studies of this species at multiple sites in the Eugene District, BLM, which will allow us to make comparisons between population size and trends at Beatty Creek and populations elsewhere in the species' range.

METHODS

Population survey

On August 26th, 2009, Intuitive Controlled surveys were employed to determine the extent of the *E. vialis* population (Whiteaker et al. 1998). As subpopulations were encountered, GPS points were recorded and notes were taken describing their sizes, locations in a landscape context, and the associated plant communities. In 2010 we conducted additional surveys on the boundaries of the population in order to refine our estimates of the extent of the population. Minor changes were made in the southernmost drainage and along Beatty Creek.

These data were summarized and used to estimate the population boundary for the *E. vialis* population in MapWindow GIS (e.g. Figure 3). A random point generator function in MapWindow was then used to place points within the polygon. A sufficient number of points were generated such that the list could be pared down to include only those points located on the east side of Beatty Creek and the south side of the six ephemeral drainages on the west slope of Beatty Creek and still have at least two points in each of the ephemeral drainages and twelve points in the Beatty Creek drainage. Points were selected in these respective areas so that transects would run perpendicular through the *E. vialis* populations (e.g. across the drainages); additionally, for ease of plot establishment and future monitoring, origin points were grouped on the same side of drainages.

Population monitoring

Twenty-two monitoring transects were established, (17 on September 15th through September 17th, 2009 and 5 on August 23rd through August 25th). Points were randomly chosen from the list of points generated in MapWindow GIS (see above); two to four transects were established in each of the six ephemeral tributaries feeding Beatty Creek (fifteen total) and seven transects were randomly established across Beatty Creek (Figure 2). Transects were located between 370 and 490 meters elevation. (An additional transect was placed just outside the northern population boundary of Beatty Creek, but is not considered in this study, because there were no plants in the transect.)

Transect origins were located using a navigation grade GPS unit (Garmin GPSmap 60CSx). At each point, a 4 foot long metal conduit was pounded into the ground so that 2 feet were protruding and a numbered metal tag was wired to its base (Table 1). The transect azimuth was determined by sighting to a distant landmark perpendicular to and across the drainage to the north (for a tributary drainage) or to the west (for the Beatty Creek drainage). Because of the variable tree and shrub density across the landscape, landmarks had to continually be sighted with a compass as a 100 meter measuring tape was stretched along the azimuth. In 2009, a short piece of metal conduit was pounded into the ground so that at least 6 inches were visible, at 100 meters; no end posts were put in place in 2010. Flagging was tied around the start and end conduits as well as around tree trunks, tree branches, and/or shrubs in the vicinity of the respective point. GPS coordinates were recorded at each origin and end (Table 1). Five photographs were taken at the origin of each transect, one at each of the cardinal directions and one along the transect itself.

All *E. vialis* occurring within 2 meters of either side of the tape were measured. Measurements included the number of stems per plant, the length of each stem, the total number of capitula per plant, and the approximate location of the plant along the transect (meter and side of the tape). The number of stems on each plant that were browsed by deer and/or insects was also recorded; deer (ungulate) damage was evidenced by stems that were clearly clipped somewhere along the stem or occasionally stems stripped of leaves, while insect damage included any type of rips or holes in *E. vialis* leaves. If deer or insect damage resulted in the loss of any capitula, an estimate of the percent of capitula damaged or lost was recorded.

Population size

Based on Intuitive Controlled surveys, transect monitoring, and aerial photographs, a polygon was created in MapWindow GIS that approximates the *E. vialis* population boundary (Figure 3). Included were all known subpopulations of *E. vialis* as well as adjacent habitat that had similar biotic and abiotic characteristics (e.g. aspect, plant community). The Calculate Polygon Area feature in MapWindow GIS was used to compute an estimate of the *E. vialis* range (245,527 m^2). Data from the monitoring transects were then scaled up to represent the population at Beatty Creek ACEC (discussed further in Results).

Table 1. Lat/Longs for transect origin and end points. The azimuth includes a 15º east declination. The coordinate datum is WGS 84. * End coordinates for transects were not recorded in 2010.

		Azimuth	Start		End	
Transect #	Tag #	(from origin)	Latitude	Longitude	Latitude	Longitude
1.1	128	337º	42.92788	-123.46471	42.92852	-123.46530
1.2	129	337º	42.92819	-123.46429	42.92878	-123.46474
2.1	127	350º	42.93020	-123.46532	42.93105	-123.46555
2.2	126	8º	42.92990	-123.46367	42.93074	-123.46365
3.1	123	8º	42.32350	-123.46418	42.93322	-123.46400
3.2	122	50º	42.93312	-123.46615	42.93363	-123.46547
4.1	117	8º	42.93436	-123.46255	42.93504	-123.46255
4.2	116	8º	42.93510	-123.46354	42.93572	-123.46349
3.3	326	30º	42.93241	-123.46479	*	*
3.4	327	8º	42.93345	-123.46692	*	*
5.1	120	8º	42.93672	-123.46206	42.93758	-123.46191
5.2	121	8º	42.93700	-123.46246	42.93784	-123.46233
5.3	324	0º	42.93783	-123.46389	*	*
6.1	131	25º	42.93882	-123.46173	42.93957	-123.46127
6.2	130	25º	42.93902	-123.46255	42.93969	-123.46208
7.1	119	270º	42.93592	-123.46059	42.93594	-123.46169
7.2	125	250º	42.93025	-123.46233	42.92983	-123.46298
7.4	124	285º	42.93180	-123.46249	42.93218	-123.46316
7.3	325	294º	42.93277	-123.46179	*	*
7.6	323	295º	42.93476	-123.46070	*	*
7.7	118	NA	42.93402	-123.46111	42.93389	-123.46212
7.13	133	260º	42.93769	-123.45989	42.93764	-123.46101

RESULTS AND DISCUSSION

Population surveys

Intuitive Controlled surveys performed in 2009 estimated 2,400 *Eucephalus vialis* individuals at 132 points within the Beatty Creek drainage and its tributaries to the west (Figure 2). Subpopulations ranged in size from 1 to greater than 150 individuals and were generally located on the north-facing slopes of the Beatty Creek tributary drainages and the east-facing slopes of the Beatty Creek drainage adjacent to the creek (between the tributary drainages). *Eucephalus vialis* also commonly occurred along game trails adjacent to the east side of Beatty Creek. Complete survey routes are shown in Figure 2.

Eucephalus vialis was commonly associated with transitional zones between mesic plant communities dominating the drainages and xeric communities on the adjacent slopes. Woody

plants common in the drainages included *Pseudotsuga menziesii, Calocedrus decurrens, Umbellularia californica, Cupressus lawsoniana, Rhododendron occidentale,* and *Holodiscus discolor,* whereas common upland associations included either *Ceanothus cuneatus* shrubland with scattered *Pinus jeffreyi* (especially on the west-facing slope of main drainage and the ridges and south-facing slopes of the tributaries) or *P. jeffreyi* savanna with scattered *Arbutus menziesii, H. discolor,* and *Toxicodendron diversilobum.* While *E. vialis* occasionally strayed farther into *P. jeffreyi* woodlands, it was never found in *C. cuneatus* shrublands. Similarly, *E. vialis* was occasionally spotted underneath denser canopy cover of *P. menziesii* and/or *C. decurrens* (especially in tributary drainages), but was never found in the interior of the more mesic and shaded habitat of the main Beatty Creek drainage (including *U. californica, C. lawsoniana,* and *R. occidentale*).

Population monitoring

In 2009, monitoring along eighteen transects recorded 443 plants with an average of 1.6 stems per plant. Reproductive plants accounted for 38% of the population (167 individuals) and supported 3,386 capitula, or about 20 capitula per reproductive plant. The average longest stem of each plant (44.8 cm) was only slightly longer than the average stem length (41.4 cm). Deer browsed 186 stems (26%) and accounted for a loss of approximately 31% of potential capitula. Insect damage was observed on 656 stems (93%) but only resulted in an estimated loss of 3.2% of potential capitula.

In 2010, monitoring of 23 transects recorded 552 plants with an average of 1.5 stems per plant. Reproductive plants accounted for 42% of the population (229 individuals) and supported 4,348 capitula or about 19 capitula per plant. The average longest stem of each plant (43.7 cm) was only slightly longer the average stem length (41.5 cm). Deer browsed 322 stems (40%) and accounted for a loss of approximately 33% of potential capitula. Insect damage was observed on 679 stems (84%) but only resulted in an estimated loss of 0.6% of potential capitula. It is unclear the effect that insect grazing on leaves leads to stress in the plant which may halt or delay the formation of flowers.

These data allow the Beatty Creek population to be compared to *E. vialis* plants located in the Eugene District BLM in Forest Canopy Thinning (FCT) plots and plots which received no canopy manipulation (unthinned)(Thorpe et al. 2010). The average longest stem length per plant was greater in the FCT compared to Beatty Creek (54.9 vs. 43.8cm respectively); the total stem length per plant was over double in the FCT plots (128.6.cm vs. 57.3cm). This trend can be attributed to a greater number of stems per plant present in the FCT population (2.3 vs. 1.5) and a slightly longer average stem length. However, a slightly greater percentage of plants flowered at Beatty Creek (41%) than in the FCT plots (36%).

The most notable difference was that populations with an open canopy (Beatty Creek and the FCT plots) had much higher flowering rates (41% and 36% respectively) than the unthinned, control plots (3%). As their name suggests, the FCT plots have been subjected to an experimental regime to determine the efficacy of different forest canopy thinning treatments in terms of plant reproduction. The Beatty Creek population is not constrained by disturbances to keep the canopy open in order to promote reproduction; the serpentine-derived substrate precludes plant communities that form dense canopies except where plenty of water is present (e.g. drainages).

Table 2. Comparison of plant data from Beatty Creek, Forest Canopy Thinning (FCT) plots and those with the canopy intact.

		FCT Plots		Unthinned plots		Beatty Creek	
		2010	**2009**	**2010**	**2009**	**2010**	**2009**
Average stem length(cm)		55.5	55.9	36.8	37.8	41.5	41.1
Average stems per plant		2.3	2.2	1.7	1.8	1.5	1.6
% Reproductive		36%	29%	3%	3%	41%	38%
Ave. Capitula per Repro. Plant		23.9	30.0	29.7	17.9	19.0	20.3
Capitula per Plant		8.5	8.8	0.88	0.58	7.9	7.6
Longest Stem (cm)		54.9	53.1	22.67	24.15	43.75	44.33
Total Stem Length (cm)		128.6	120.7	47.59	48.78	57.3	61.8
Deer Browse	**(#) Stems**	0.8	0.6	0.3	0.1	0.4	0.4
	(%) Capitula	10.5	3.0	0	0	33.9	21.0
Insect Herbivory	**(#) Stems**	2.1	1.9	1.2	1.3	0.8	1.5
	(%) Capitula	0.0	0.8	0	0	0.7	3.7

Population size

In estimating the population size, only the portions of the transects that were within the population boundary established during the Intuitive Controlled surveys were utilized. In 2009 monitoring transects covered 5,760 m^2, or about 2.3% of the *E. vialis* habitat. While four transects contained a significant number of plants (0.11 to 0.27 plants/m^2), 12 contained between 1 and 36 plants (0.0025 to 0.09 plants/m^2), and one transect contained no plants (Table 2). The average number of plants/m^2 was 0.06; the estimated *E. vialis* population at Beatty Creek is 18,684 ± 7,294 individuals (± 90% C.I.). This population size may be an underestimated as the polygon area does not account for topographical relief.

In 2010, we surveyed 3.1% of the population (7,588 m^2) and estimated that total population size was 17,163 ± 6,662 individuals (± 90% C.I.). Similar to observations in 2009, the number of plants per transect ranged from zero to 122 and the average plant density was 0.07 plants/m^2.

In 2010, we surveyed several areas near the boundary defined in 2009 to refine our estimate of the total area occupied by *E. vialis*. Although we did not find any additional *E. vialis*, there is still a small possibility that there are individuals outside of our population boundary.

Recommended actions

There are currently relatively few negative impacts on the *E. vialis* population at Beatty Creek. The serpentine soils that characterize the site provide some resistance to invasive plants and canopy closure by native trees. The greatest impacts to *E. vialis* at Beatty Creek are expected from changes in the management of Beatty Creek ACEC or surrounding areas and global climate change.

We recommend monitoring the transects in this population every three years. This timing should allow for detection of significant changes in population status while being an efficient use

of resources. In future years, additional conduit should be added to each transect (e.g. at every 25m) in order to assist with sighting the transect orientation. This would allow a comparison of not only shifts in total population, but also shifts in plant density throughout the population.

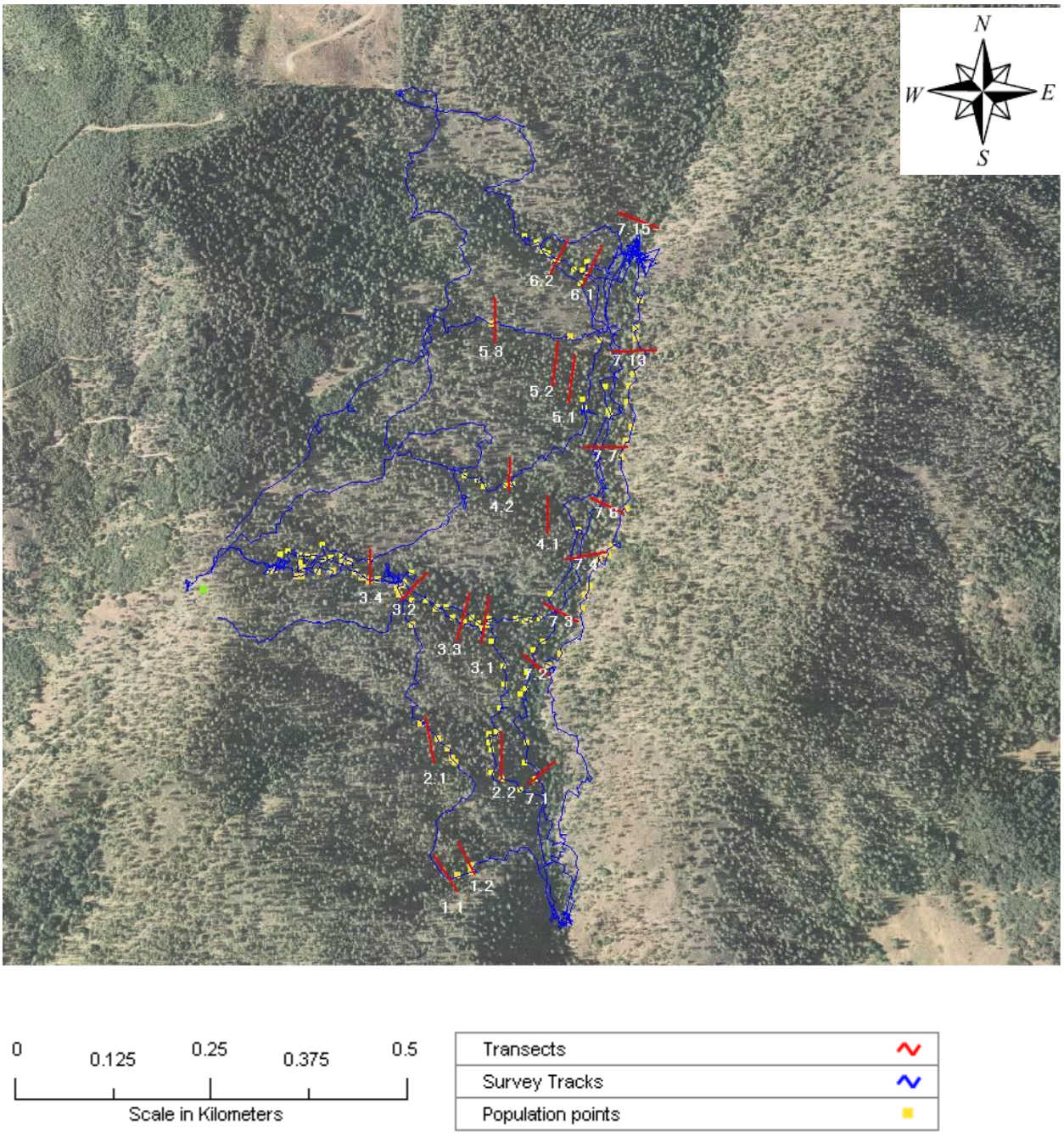

Figure 2. Intuitive Controlled survey routes (blue lines), *E. vialis* subpopulations (yellow points), and monitoring transects (red lines) at Beatty Creek ACEC. Population surveys started from a vehicle parked near the green point at the western edge of the photo. The *E. vialis* populations ranged in size from 1 to greater than 150 individuals. Additional populations found along transects are not shown. The white numbers are the identifiers of the 22 monitoring transects. All transects were 100 meters long, some lines are shorter because of significant topographic relief between the starting and ending points. Transect 7.15 is not included in the population estimates as it was found to be outside of the population boundary.

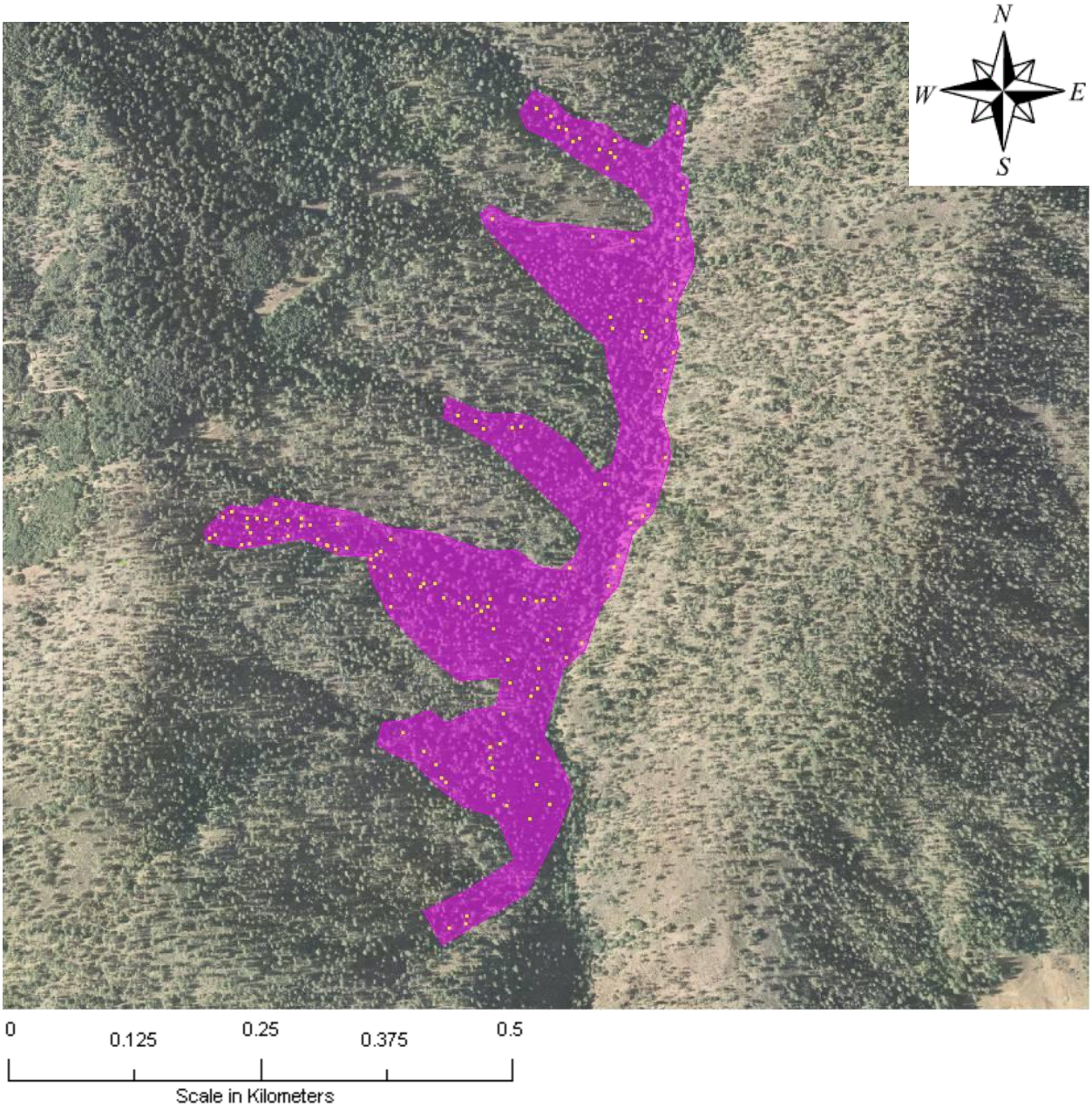

Figure 3. Estimated extent of *Eucephalus vialis* population based on population surveys and population monitoring transects. Populations recorded during Intuitive Controlled surveys are shown with yellow dots.

Table 3. Results of *E. vialis* monitoring along 17 transects located at Beatty Creek ACEC in 2009.

Transect #	Area (m^2)	Tag #	Number of plants	Average # stems per plant	Average stem length (cm)	Average longest stem length (cm)	Total # capitula	Deer Browsed		Insect Browsed	
								Total # stems	Average % capitula	Total # stems	Average % capitula
1.1	300	128	1	1.0	17.0	17.0	0	1	100.0	1	0.0
1.2	320	129	25	1.3	46.6	47.9	203	3	6.0	33	6.4
2.1	280	127	2	2.0	41.8	50.5	0	0	0.0	4	0.0
2.2	400	126	44	1.3	39.2	42.1	139	6	4.4	58	3.6
3.1	400	123	69	1.6	38.2	42.2	390	31	27.5	105	0.0
3.2	200	122	68	2.2	65.9	71.8	1647	17	10.6	149	13.5
4.1	400	117	9	1.3	31.0	31.9	11	5	33.3	8	5.6
4.2	264	116	8	1.3	28.5	29.3	2	7	78.6	9	0.0
5.1	400	120	16	1.9	44.4	48.6	59	13	40.8	30	0.9
5.2	400	121	109	1.3	25.4	26.4	215	38	14.1	107	0.0
6.1	256	131	13	1.5	53.6	57.9	121	2	15.4	18	0.0
6.2	328	130	36	1.8	32.0	34.9	185	35	39.6	60	3.2
7.1	360	119	10	1.6	56.6	58.9	76	9	65.4	16	6.0
7.2	324	125	0								
7.4	400	124	14	2.1	55.5	64.4	156	5	4.9	30	10.9
7.7	400	118	15	1.4	53.5	57.0	182	14	56.0	20	0.7
7.13	328	133	4	2.0	33.4	35.3	0	0	0.0	8	0.0
AVERAGES:	339		26.1	1.6	41.4	44.8	211.6				
TOTALS:	5760		443				3386	186		656	
Estimated population size						***18,684 ± 7,294 (90%C.I.)***					

Table 3 Cont. Results of *E. vialis* monitoring along 22 transects located at Beatty Creek ACEC in 2010.

Transect #	Area (m^2)	Tag #	Number of plants	Average stem length (cm)	Average # stems per plant	Average longest stem length (cm)	Total # capitula	Deer Browsed		Insect Browsed	
								Total # stems	Average % capitula	Total # stems	Average % capitula
1.1	300	128	8	55.3	1.5	74.1	117	0.9	43.1	1.3	10.0
1.2	320	129	54	59.3	1.5	75.2	541	0.3	12.7	1.0	0.9
2.1	280	127	5	52.0	2.4	85.0	24	1.0	50.0	1.0	0.0
2.2	400	126	21	49.3	1.3	56.1	180	0.4	36.2	1.3	0.0
3.1	400	123	36	39.6	1.3	47.4	244	0.8	28.0	1.0	0.4
3.2	200	122	45	45.8	1.7	63.7	360	1.0	48.8	1.2	0.0
3.3	400	326	75	54.8	1.9	86.1	1239	0.5	23.0	1.6	0.0
3.4	400	327	62	44.2	1.5	58.4	827	0.7	34.2	1.4	0.0
4.1	400	117	4	37.3	2.8	84.3	0	2.5	100.0	2.8	0.0
4.2	264	116	16	28.9	1.4	37.1	5	0.9	78.4	1.3	0.0
5.1	400	120	7	39.9	1.7	62.7	6	0.4	42.9	1.7	14.3
5.2	400	121	122	29.2	1.2	32.5	206	0.5	36.6	1.0	1.0
5.3	400	324	18	44.3	1.2	48.9	134	0.6	39.4	1.1	0.0
6.1	256	131	15	43.2	1.4	56.8	149	0.5	38.3	1.3	0.0
6.2	328	130	33	45.9	1.3	53.9	356	0.7	32.8	1.2	0.0
7.1	360	119	10	57.4	1.2	67.9	64	0.7	65.0	1.2	1.0
7.2	324	125	0								
7.3	400	325	0				0				
7.4	400	124	0								
7.7	400	118	15	48.1	1.5	65.1	0	0.2	6.7	1.5	0.0
7.6	228	323	0								
7.13	328	133	6	26.8	1.3	33.8	0	0.5	16.7	1.3	0.0
AVERAGES:	335.5		25.1	44.5	1.6	60.5	234.3	0.7	40.7	1.3	1.5
TOTALS:	7588		552				4452				

Estimated Population size ***17,163 ± 6,662 (90%C.I.)***

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APPENDIX A. GEAR LIST, DATASHEETS, AND DIRECTIONS

Gear List for EUVI – Roseburg

100 meter tape (2)
Candy canes (4)
1 meter plot frame sections (4)
Compass
Tatum and Clipboard
Pencils
Extra lead
Data sheets (Rite in Rain)
Rulers (4)
Flora
GPS
Camera
Extra batteries
Gazetteer
Roseburg Resource Area transportation map (the one with the route highlighted)
Flagging
Conduit (1 tall, 1 small per plot)
Mallet
Wire
Numbered tags
Pliers
Aerial photos and local topos
Water jugs
Health and safety box (make sure there is tecnu)
Camping gear

Eucephalus vialis, Beatty Creek

Names:

Transect #: | GPS Coords (Datum =): | Start:

Date: | Azimuth (from origin): | End:

				Deer Browse		Insect Browse		
Plant #	# stems	Stem Lengths (cm)	# capitula	# stems	% capitula	# stems	% capitula	NOTES

Directions to Beatty Creek ACEC/RNA

From I-5, take exit 103 and drive west on Riddle Bypass Road (Pruner Rd). After ~6 miles, slight right onto Cow Creek Road (might seem like road just continues). After ~3.7 miles there is another slight right to stay on Cow Creek Road. Drive ~2 miles and turn right onto Doe Creek Rd (you have to cross over railroad tracks, BLM 30.7.23). Reset your odometer once you turn onto Doe Creek. All mileages hereafter are from the junction of Cow Creek and Doe Creek Roads. Stay right after ~1.1 miles. After ~1.9 miles turn right. At about 2.5 miles you will reach a 3- or 4-way junction, take a hard left. Stay right at ~2.6 miles. Stay right at ~3.0 miles. At ~3.7 miles take a right off of the improved road. At ~4.4 miles stay right (road looks even worse). At 5.0 miles you are at the parking place. There are several spots in the last section that are washed out and passable only with a high clearance vehicle and someone spotting the driver. Be careful! It would be better to walk the extra quarter mile than to get a tow truck out here.